Section 4

Air Pollution and Solutions

Objectives

After this lesson, students will be able to

E.4.4.1 Identify the causes of smog and acid rain.

E.4.4.2 Describe the causes of indoor air pollution.

E.4.4.3 Explain the key to reducing air pollution.

Target Reading Skill

Relating Cause and Effect Explain that cause is the reason for what happens. The effect is what happens because of the cause. Relating cause and effect helps students relate the reason for what happens to what happens as a result.

Answers

Possible causes include the following: Factory and power plant emissions that produce nitrogen oxides and sulfur oxides when they burn coal and oil; gases emitted by automobiles and trucks; indoor air pollutants, such as toxic chemicals

All in One Teaching Resources

- Transparency E34

Preteach

Build Background Knowledge

L2

Air Pollution Examples

Encourage students to describe specific examples of air pollution that they have seen in person or in pictures, such as smog hanging over a city, smoke coming from factory smokestacks, and grime or pollen settling on cars parked outdoors. Ask: **Which of these types of air pollution do you think we could control?** *(Accept all responses without comment at this time.)*

Section 4

Air Pollution and Solutions

Reading Preview

Key Concepts

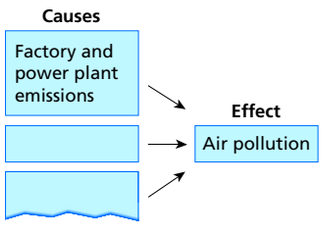
- What are the causes of smog and acid rain?
- What are the causes of indoor air pollution?
- What is the key to reducing air pollution?

Key Terms

- emissions
- photochemical smog
- ozone
- temperature inversion
- acid rain
- radon

Target Reading Skill

Relating Cause and Effect As you read, identify three causes of air pollution. Write the information in a graphic organizer like the one below.



Lab zone Discover Activity

How Does the Scent Spread?

1. Choose a place to stand so that you and your classmates are evenly distributed around the room.
2. Your teacher will spray some perfume in one corner of the room.
3. Raise your hand when you first smell the perfume.

Think It Over

Inferring Describe the pattern you observed as people raised their hands. How do you think the scent traveled across the room?

You can't see, taste, or smell it, but you are surrounded by it. It's air, of course! But what is air? Air is a mixture of nitrogen, oxygen, carbon dioxide, water vapor, and other gases. Almost all living things depend on these gases to carry out their life processes. Recall from Chapter 2 that these gases cycle between the atmosphere and living things. These cycles guarantee that the air supply will not run out. But they don't guarantee that the air will be clean.

What causes air pollution? Perhaps you picture a smokestack belching thick, black smoke into the sky. Until the mid-1900s, in the United States, factories and power plants that burned coal produced most of the **emissions,** or pollutants that are released into the air. Today, there is a larger source of emissions: motor vehicles such as cars and trucks. There are some natural causes of air pollution, as well. For example, an erupting volcano sends an enormous load of pollutants into the atmosphere.

Traffic jam ▶

Lab zone Discover Activity

Skills Focus Inferring

L1

Materials spray bottle with perfume

Time 5 minutes

Tips Make sure students are evenly spaced throughout the room so that the scent will reach different students at different times.

Expected Outcome Students closest to you will smell the perfume first, and those standing farthest away will smell it last.

Think It Over Students will see a "wave" of raised hands traveling from you to the farthest parts of the room. Students should infer that molecules of perfume traveled across the room in the air.

FIGURE 16
Temperature Inversion
Normally, pollutants rise into the atmosphere and blow away. But during a temperature inversion, a layer of warm air traps pollutants close to the ground.
Interpreting Photographs *What is the brownish haze?*

Smog

Have you ever heard a weather forecaster talk about a "smog alert"? A smog alert is a warning about a type of air pollution called photochemical smog. **Photochemical smog** is a thick, brownish haze formed when certain gases in the air react with sunlight. When the smog level is high, it settles as a haze over a city. Smog can cause eye and throat irritation and breathing problems. Exercising outdoors can make these problems worse.

Sources of Smog **The major sources of smog are the gases emitted by automobiles and trucks.** Burning gasoline in a car engine releases some gases into the air. These gases include hydrocarbons (compounds containing hydrogen and carbon) and nitrogen oxides. The gases react in the sunlight and produce a form of oxygen called **ozone.** Ozone, which is toxic, is the major chemical found in smog. Ozone can cause lung infections and damage the body's defenses against infection.

Temperature Inversion Normally, air close to the ground is heated by Earth's surface. As the air warms, it rises into the cooler air above it. Any pollutants in the air are carried higher into the atmosphere where they blow away from the place where they are produced.

Certain weather conditions cause a condition known as a temperature inversion. During a **temperature inversion,** a layer of warm air prevents the rising air from escaping. The polluted air is trapped and held close to Earth's surface. The smog becomes more concentrated and dangerous.

Reading Checkpoint **What is the major chemical found in smog?**

Go Online PLANET DIARY
For: More on air pollution
Visit: PHSchool.com
Web Code: ced-5044

Instruct

Smog

Teach Key Concepts L2

Causes of Smog

Focus Ask: **How would you describe smog?** *(Possible answer: A brown, hazy layer of gas in the air)*

Teach Ask: **What gases are the sources of smog?** *(Hydrocarbons and nitrogen oxides emitted by automobiles and trucks)* **How do these gases form smog?** *(They react with sunlight to form ozone.)* **What other factor must be present for smog to form?** *(Temperature inversion)* Point out that ozone is harmful when it is close to Earth's surface. Ozone in the upper atmosphere filters ultraviolet radiation.

Apply Ask: **Why are most smog alerts issued in summer?** *(The gases react with sunlight, which is more intense in summer.)* **learning modality: logical/mathematical**

All in One Teaching Resources
- Transparency E35

Independent Practice

All in One Teaching Resources
- Guided Reading and Study Worksheet: *Air Pollution and Solutions*

Student Edition on Audio CD

Go Online PLANET DIARY
For: More on air pollution
Visit: PHSchool.com
Web Code: ced-5044
Students can review air pollution in an online interactivity.

Differentiated Instruction

English Learners/Beginning L1
Vocabulary: Word Analysis Explain that the word *smog* comes from parts of two other words put together. To clarify how the word *smog* was created, write *smoke* + *fog* on the board, and have students tell what each word means. Then erase *oke* and *f,* and write = *smog*. **learning modality: verbal**

English Learners/Intermediate L2
Vocabulary: Word Analysis Repeat the Beginning activity. Then ask students to look up the word *photochemical* and give the meaning of *photo (light)*. Show them a familiar item, a photograph, and point out that the connection between the word parts in *photograph* is the same as the connections in *photochemical*. **learning modality: verbal**

Monitor Progress L2

Skills Check Have students sequence how smog is formed.

Answers
Figure 16 Smog
Reading Checkpoint Ozone

Acid Rain

Teach Key Concepts L2

Causes and Effects of Acid Rain

Focus Remind students that an acid is a substance that has a pH lower than 7.0.

Teach Ask: **How is acid rain formed?** *(Nitrogen oxides and sulfur oxides react with water vapor to form nitric acid and sulfuric acid, which fall to Earth as precipitation.)* **How does acid rain affect living things?** *(It damages trees and other plants, and can kill fish and other aquatic organisms.)*

Apply Tell students that each whole pH value below 7 is ten times more acidic than the next higher value. Normal rain has a pH of 5.5. The most acidic rain in the U.S. has a pH of about 4.3. Ask: **How much more acidic is acid rain than normal rain?** *(About ten times)* **learning modality: logical/ mathematical**

Lab zone Build Inquiry L2

Observing Effects of Air Pollutants

Materials hand lens, foam cup, piece of nylon-stocking fabric, scissors, tape

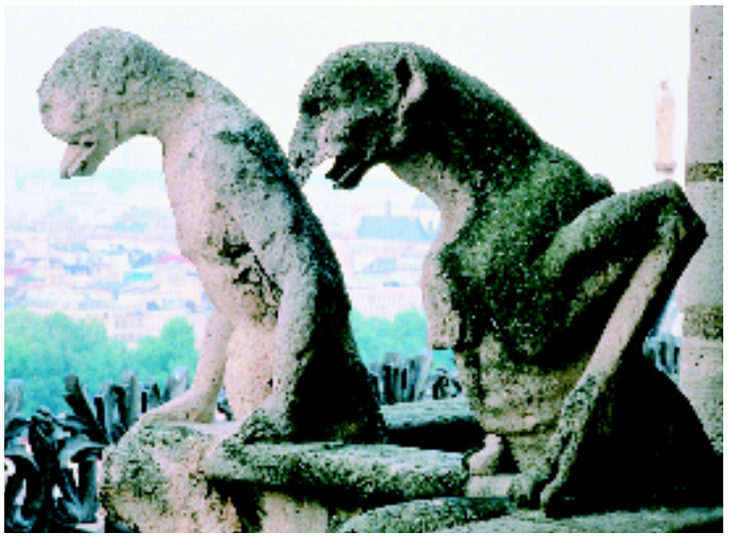
Time 10–15 minutes for setup, plus follow-up observations

Focus Ask: **Do you think the air you are breathing today is clean?** *(Unless pollution is obvious, most will say yes.)*

Teach Have students examine the fabric with a hand lens. Ask them to pull and twist the fabric to test its strength and flexibility and to make notes about their observations. Then have each student cut out the bottom of the cup and tape a piece of stocking over the opening. Have students hang the cups outdoors where they will be exposed to air and rain. After a week, have students observe the fabric for strength, flexibility, and broken fibers or other signs of damage.

Apply Ask: **Do you agree with your original answer?** *(Most students will think that the air is polluted because of the negative effects on the nylon.)* Point out that air pollution can affect the nylon but sunlight also has a negative effect on it. **learning modality: visual**

FIGURE 17
Acid Rain
Acid rain can react with the stone in statues.
Inferring *Why do these statues look like they are melting?*



Acid Rain

Precipitation that is more acidic than normal because of air pollution is called **acid rain.** Acid rain can be in the form of snow, sleet, or fog as well as rain. **Acid rain is caused by the emissions from power plants and factories that burn coal and oil.** These fuels produce nitrogen oxides and sulfur oxides when they are burned. These gases react with water vapor in the air, forming nitric acid and sulfuric acid. The acids return to Earth's surface dissolved in precipitation.

As you can imagine, acid falling from the sky has some negative effects. When acid rain falls into a pond or lake, it changes the conditions there. Many fish, and particularly their eggs, cannot survive in more acidic water. When acid rain falls on plants, it can damage their leaves and stems. Acid rain that falls on the ground can also damage plants by affecting the nutrient levels in the soil. Whole forests have been destroyed by acid rain. Fortunately, some of the effects of acid rain are reversible. Badly damaged lakes have been restored by adding substances such as lime that neutralize the acid.

Acid rain doesn't just affect living things. The acid reacts with stone and metal in buildings and statues. Statues and stonework damaged by acid rain may look as if they are melting. Automobiles rust more quickly in areas with acid rain. These effects are not reversible.

Reading Checkpoint **How can acid rain affect nonliving things?**

Lab zone Try This Activity

How Acid Is Your Rain?

In this activity you will test whether rain in your area is more or less acidic than lemon juice (citric acid).

1. Collect some rainwater in a clean plastic cup.
2. Indoors, dip a piece of pH paper into the cup. Compare the color of the paper to the chart on the package to find the pH. (The lower the pH of a substance, the more acidic it is.)
3. Pour a little lemon juice into a plastic cup. Repeat Step 2 with the lemon juice.

Measuring What is the pH of the rainwater? How does it compare to the pH of the lemon juice?

Lab zone Try This Activity

Skills Focus Measuring L2

Materials rainwater, 2 plastic cups, pH paper, pH chart, lemon juice

Time 10 minutes

Tips Collect rainwater ahead of time for this activity.

Expected Outcome Rainwater is normally slightly acidic (pH of about 5.6); a pH lower than 5.6 indicates acid rain. Lemon juice has a pH of 2.

Extend Have students measure the pH of tap water and compare it with their pH measurements of rainwater and lemon juice. **learning modality: logical/ mathematical**

Indoor Air Pollution

You might think that you can avoid air pollution by staying inside. But in fact, the air inside buildings can be polluted, too. **Some substances that cause indoor air pollution, such as dust and pet hair, bother only those people who are allergic to them. Other indoor air pollutants, such as toxic chemicals, can affect anyone.** Glues and cleaning supplies may give off toxic fumes. And cigarette smoke, even from another person's cigarette, can damage the lungs and heart.

Carbon Monoxide One particularly dangerous indoor air pollutant is carbon monoxide. Carbon monoxide is a colorless, odorless gas that forms when wood, coal, oil, or gas are incompletely burned. When carbon monoxide builds up in an enclosed space such as an apartment or house, it can be deadly. Any home heated by wood, coal, oil, or gas should have a carbon monoxide detector.

Radon Another indoor air pollutant that is difficult to detect is radon. **Radon** is a colorless, odorless gas that is radioactive. It is formed naturally by certain types of rocks underground. Radon can enter homes through cracks in basement walls or floors. Research indicates that breathing radon gas over many years may cause lung cancer and other health problems. But the level of radon necessary to cause these effects is unknown. To be safe, some homeowners have installed ventilation systems to prevent radon from building up in their homes.

Reading Checkpoint **What is carbon monoxide?**

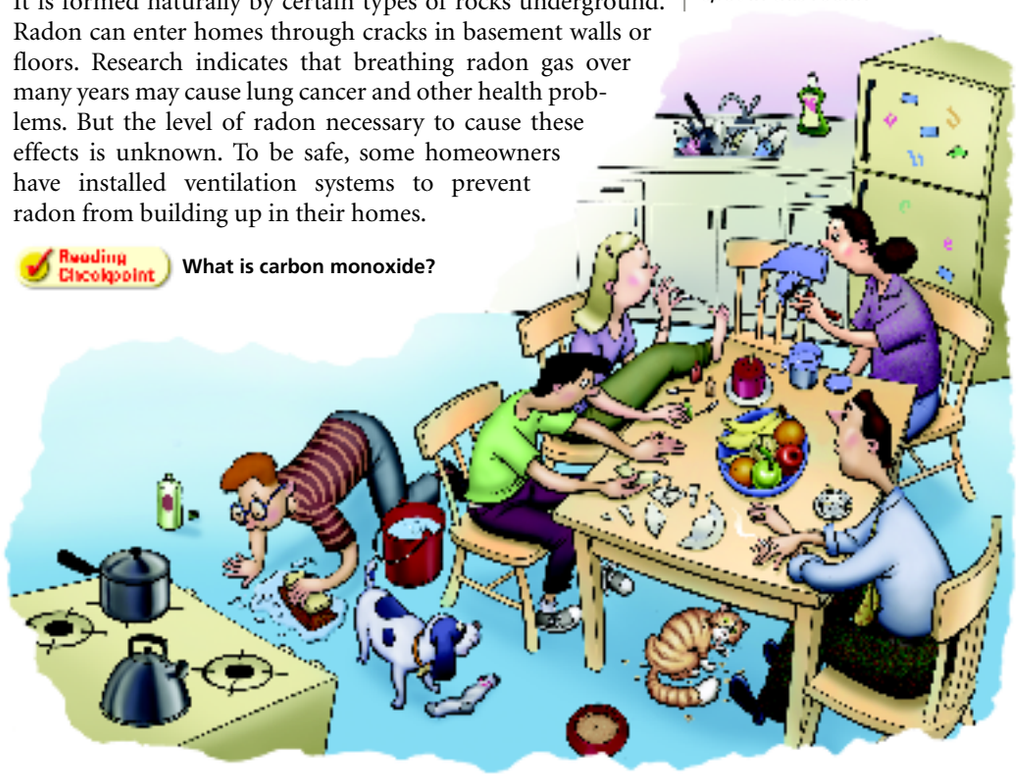


FIGURE 18
Indoor Air Pollution
Air inside buildings can be polluted, too. **Observing** *How many sources of pollution can you spot in this room?*

Differentiated Instruction

Special Needs L1
Writing Captions Pair students with more able students. Distribute photocopies of Figure 18. Suggest that students write a caption for each source of indoor pollution shown. Then have students add other sources of air pollution to the drawing (indoors or from outdoors) and write captions for those. **learning modality: visual**

Less Proficient Readers L1
Analyzing Word Parts Write *carbon dioxide* and *carbon monoxide* on the board, and ask students to identify the difference between the words. Explain that *di* means "two," and *mono* means "one." Carbon dioxide has two atoms of oxygen, and carbon monoxide has one atom. Draw a diagram of each molecule. **learning modality: visual**

Indoor Air Pollution

Teach Key Concepts L2

Sources of Indoor Air Pollution

Focus Remind students that many different sources can pollute indoor air.

Teach Ask: **What are some sources of indoor air pollution?** *(Dust, pet hair, glues, and cleaning supplies)* **Why are carbon monoxide and radon difficult to detect?** *(They are colorless and odorless.)*

Apply Have students contact the local health department or environmental agency to find out if radon is found in your area. **learning modality: logical/mathematical**

Lab zone Build Inquiry L2

Identifying Indoor Pollutants

Materials containers of products that give off toxic fumes

Time 10 minutes

Focus Review the names of products that can cause indoor air pollution.

Teach Tell students that many product labels have information about safe handling and use. Display the products, and have volunteers read aloud the cautionary statements on the labels. **CAUTION:** *Instruct students not to open any container.*

Apply Ask: **How can these products be used safely?** *(Usually outside or in well-ventilated areas)* **learning modality: verbal**

Monitor Progress L2

Oral Presentation Call on students to name one source of air pollution.

Answers
Figure 17 Acid rain has reacted with the statues, eating away some of the stone.
Figure 18 Cigarette smoke, cat and dog dander, glue, nail polish, paint, cleansers

Reading Checkpoint Acid rain reacts with stone and metal in buildings and statues and damages them.

Reading Checkpoint A colorless, odorless gas that forms when wood, coal, oil, or gas is incompletely burned

Reducing Air Pollution

Teach Key Concepts L2

Controlling Emissions

Focus Review with students the various sources of air pollution.

Teach Tell students that the amount of emissions that can be released into the air by automobiles and factories is regulated by law. Ask: **How are emissions controlled in cars and trucks?** *(By pollution-control devices such as catalytic converters)* Have students study Figure 19. Ask a volunteer to describe how gas is cleaned in this smokestack scrubber.

Apply Ask: **How can individuals help reduce emissions?** *(Use less energy by reducing use of electricity and gas)* **learning modality: visual**

Integrating Health L2

Ask students to hypothesize why some respiratory problems, such as asthma, bronchitis, and emphysema, are caused or worsened by breathing polluted air. *(Possible answer: Pollutants damage the lungs.)* Provide brochures or Internet printouts from reliable sources, such as the American Lung Association and the U.S. Environmental Protection Agency. Encourage students to make posters that include a labeled diagram of the respiratory system and a brief description of how the system is affected. **learning modality: visual**

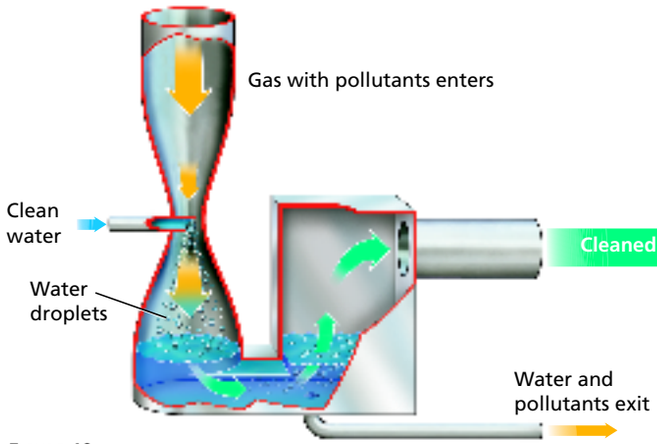


FIGURE 19
Controlling Factory Emissions
A smokestack scrubber removes pollutants such as sulfur dioxide from emissions. The dirty gas passes through a tube containing water droplets. Pollutants dissolve in the water, leaving clean gas to flow out of the chamber. The dirty water still must be properly disposed of. **Inferring** *Why aren't scrubbers a perfect solution to the emissions problem?*

Reducing Air Pollution

The key to reducing air pollution is to control emissions. In the United States, laws such as the Clean Air Act regulate the amount of certain pollutants that can be released into the air. These laws also encourage the development of new technology that reduces air pollution. But reducing emissions requires not only new technology but also the efforts of people like you.

Controlling Emissions From Factories At one time, industries dealt with emissions by building tall smokestacks. The stacks released wastes high in the air, where they could blow away. But the pollutants still ended up somewhere. Now factories place devices in the stacks to treat emissions. The device in Figure 19, called a scrubber, removes pollutants from emissions using a stream of water droplets. Pollutants dissolve in the water and fall into a container. The use of scrubbers explains why "smoke" from factories is white—it's not smoke, it's steam.

Controlling Emissions From Vehicles Cars and trucks now contain pollution-control devices. For example, a catalytic converter is a device that reduces emissions of carbon monoxide, hydrocarbons, and nitrogen oxides. This device causes the gases to react, forming less-harmful carbon dioxide and water.

Laws can ensure that people use pollution-control devices. For example, in many states, cars must pass emissions tests. The state of California's strict emissions-testing laws have helped reduce the smog problem in Los Angeles in recent years.

What You Can Do You may not think there is much you can do to reduce air pollution. But in fact, some small changes in people's behavior can make a big difference.

You can help reduce air pollution by reducing certain types of energy use. Much air pollution is a result of burning fuels to provide electricity and transportation. Using less energy conserves fuel resources and also reduces emissions. When you take public transportation, carpool, walk, or ride a bicycle, there is one fewer car on the road. This means there are fewer emissions that contribute to air pollution.

Reading Checkpoint **What are two things you can do to help reduce air pollution?**

FIGURE 20
Reducing Air Pollution
Commuting to school or work by bicycle is one way to reduce the emissions that cause air pollution.

Section 4 Assessment

Target Reading Skill **Relating Cause and Effect** Refer to your graphic organizer about air pollution to help you answer Question 1 below.

Reviewing Key Concepts

1. **a.** **Reviewing** What causes smog? What causes acid rain?
   b. **Comparing and Contrasting** How are the causes of smog and acid rain similar? How are they different?
2. **a.** **Listing** Give four examples of indoor air pollutants.
   b. **Classifying** Which of the indoor air pollutants you listed bother only those people who are allergic to them? Which can affect anyone?
   c. **Predicting** New homes today are better insulated and more airtight than older homes. How might this affect indoor air pollution problems?
3. **a.** **Identifying** What is the one key to the reduction of air pollution?
   b. **Applying Concepts** Use an example to explain how new technology can help reduce emissions.
   c. **Inferring** One bus produces more emissions than one car. Yet increasing the number of people who travel by bus results in fewer emissions overall. Explain.

Lab zone **At-Home Activity**

It's in the Air What solid particles are in your air? With a family member, set up two particle collectors. Smear petroleum jelly on the inside of two clean, empty glass jars. Place one inside your home and the other outside. Make sure both jars are in locations where they will not be disturbed. Predict what you will find if you leave the jars in place for a few days. Compare the solid particles in each jar. How similar are they? Can you identify any of the particles?

Monitor Progress L2

Answers

Figure 19 The dirty water still must be disposed of.

Reading Checkpoint Any two: walk instead of ride in a car, ride a bicycle, take public transportation, carpool

Assess

Reviewing Key Concepts

1. a. Smog forms when certain gases in the air, such as those produced by burning gasoline, react with sunlight. Acid rain is caused by emissions from power plants and factories that burn coal and oil. **b.** Both are caused by emissions. Smog contains hydrocarbons and nitrogen oxides that react in sunlight to produce ozone. Acid rain contains nitric acid and sulfuric acid, formed as nitrogen oxides and sulfur oxides react with water vapor in the atmosphere.
2. a. Any four: cigarette smoke, animal hair, dust, radon, carbon monoxide, paint fumes, fumes from cleaning supplies, glue **b.** Animal hair and dust affect only those sensitive to them; cigarette smoke, radon, carbon monoxide, and fumes from paint, cleansers, and glue affect everyone. **c.** An insulated and airtight house will have less fresh air circulation and may trap more indoor pollution.
3. a. Control emissions **b.** Possible answer: Catalytic converters on automobiles reduce emissions of carbon monoxide, hydrocarbons, and nitrogen oxides. **c.** More people can ride on one bus than can ride in one car. Many cars on the roads have only one occupant—the driver.

Reteach L1

As a class, list the types of air pollution, their causes, and ways to control or eliminate each.

All in One Teaching Resources

- Section Summary: *Air Pollution and Solutions*
- Review and Reinforce: *Air Pollution and Solutions*
- Enrich: *Air Pollution and Solutions*

Lab zone **Chapter Project**

Keep Students on Track Advise students to complete their project models and begin testing them. Remind students that they must show how the product is protected, using fewer materials in the packaging. Encourage students to change their models at this time if necessary.

Lab zone **At-Home Activity**

It's in the Air L1 Suggest that students place the inside jar in a busy room, such as the kitchen or living room, and the outside jar in their yard or close to a driveway or street. Depending on the time of year, students may observe pollen grains as well as dust, pet hair, soot, and the like.

How Does the Garden Grow? L3

Prepare for Inquiry

Key Concept
Pollutants in water reduce seed germination and injure growing plants.

Skills Objectives
Students will be able to
- control the correct variables
- interpret data on seed germination and plant growth
- design an experiment to test the effect of a possible pollutant on the growth of radish seeds

Prep Time 30 minutes
Class Time Day 1, 30 minutes; Days 2–6, 5 minutes each

All in One Teaching Resources
- Lab Worksheet: *How Does the Garden Grow?*

Advance Planning
Let tap water stand uncovered for 24–48 hours to allow chlorine to dissipate. Prepare each polluted solution by mixing 5 mL of the pollutant with 100 mL of water. (For acid, use vinegar; for oil, use vegetable oil.)

Safety
Stress to students the importance of washing their hands well with soap after handling the seeds and soil. Review the safety guidelines in Appendix A.

Lab zone Design Your Own Lab

How Does the Garden Grow?

Problem
How do pollutants affect seed growth?

Skills Focus
controlling variables, interpreting data, designing experiments

Suggested Materials
- 2 plastic petri dishes with lids
- wax pencil
- potting soil
- acid solution
- 20 radish seeds
- oil solution
- detergent solution
- salt solution
- day-old tap water
- masking tape
- 10-mL graduated cylinder
- metric ruler

Procedure

PART 1 Observing the Effects of a Known Pollutant

1. Read all the steps of the lab. Write a hypothesis about how an acid solution might affect the growth of radish seeds. Then copy the data table into your notebook.
2. Write your initials on the lids of the petri dishes. Then write "Control" on one lid. Label the other lid "Acid Solution."
3. Fill each dish with potting soil. Do not pack down the soil.
4. Pour 10 mL of water into the control dish. Pour 10 mL of the acid solution into the pollutant dish. Lightly scatter ten seeds on the soil surface in each dish.
5. Cover each dish with the correct lid. Tape the lids firmly in place. Store the dishes where they will receive light and will not be moved. Wash your hands with soap.
6. Once a day for the next five days, observe the seeds (do not open the lids). Record your observations in the data table. Use a metric ruler to measure the length of any roots or shoots that develop. If you do not observe any change, record that observation.

PART 2 Observing the Effects of a Possible Pollutant

7. Using the procedures you followed in Part 1, design an experiment that tests the effect of a possible pollutant on the growth of radish seeds. (*Hint:* You may use one of the remaining solutions listed under Suggested Materials.) Be sure to write a hypothesis and control all necessary variables.
8. Submit your experimental plan to your teacher for review. After making any necessary changes, create a data table in which to record your observations. Then carry out your experiment.

Data Table

Date	Number of Seeds That Germinated		Condition of Seedlings	
	Control	Pollutant (Acid Solution)	Control	Pollutant (Acid Solution)

Guide Inquiry

Invitation
Ask: **Why is it important to know how pollutants affect seed growth?** *(Accept all reasonable answers, such as how to use this information to reduce pollution or clean it up.)* Then have students brainstorm a list of reasons for having healthy plant growth in ecosystems, gardens, and farms based on what they already know about biogeochemical cycles, worldwide human hunger, and pollution.

Analyze and Conclude

1. **Observing** In Part 1, how many seeds germinated each day in the control dish? In the pollutant dish? What was the total number of seeds that germinated in each dish?
2. **Controlling Variables** In Part 1, how did the preparation of the two petri dishes differ? How was this difference important to the investigation?
3. **Interpreting Data** In Part 1, did the seedlings grown under the two conditions differ? If so, how?
4. **Drawing Conclusions** In Part 1, did your results support your hypothesis? Explain.
5. **Designing Experiments** What was the manipulated variable in Part 2? What was the responding variable?
6. **Inferring** In Part 2, did the solution you chose act as a pollutant? Explain.
7. **Communicating** Write a paragraph explaining what the effect would be if the pollutant you investigated in Part 2 reached a vegetable garden or farm.

More to Explore

Do you think the pollutant you studied in Part 1 has the same effect on all types of plants? Explain your reasoning. How might you test your hypothesis?

Extend Inquiry

More to Explore Students' plans should involve controlling all variables except the types of plants.

Introduce the Procedure

Before students begin, discuss these terms; *hypothesis, variable,* and *control*. Ask: **What is the importance of having a control?** *(The control will show the effects of any other environmental condition that might affect the outcome other than the variable tested. In this way, there is a greater certainty that any effect observed in the experiment is due only to the variable.)*

Troubleshooting the Experiment

- Advise students to make sure the hypothesis is a testable statement.
- Monitor students' choices of places to put the two dishes.

Expected Outcome

All or most seeds in the control dish should germinate within two or three days, and grow well. Some or all seeds in the pollutant dish will fail to germinate, and any sprouts will not grow well.

Analyze and Conclude

1. Answers will vary. Pollutants usually reduce the number of seeds that germinate.

2. Water was added to one dish while acid was added to the other. It showed that the cause of any differences in the growth of seeds was due to this one variable.

3. Yes; seedlings in the acid dish did not grow as well as those in the control dish.

4. Answers will depend on hypotheses.

5. Answers will depend on the solution chosen to test. The detergent, oil, or salt preparations will act as a pollutant and inhibit germination and/or growth.

6. Yes; the solution would not normally be found in healthy soil and the solution damaged the seeds, which is how pollutants would affect seeds.

7. Paragraphs may include that fewer seeds would germinate, and the seedlings that did sprout would not grow into healthy plants.